Introduction - Scalar Fields

- Scalar fields are visualized by heat maps (color codings) classically
- Each position in space is mapped a scalar height value
- Examples: temperature field, height field

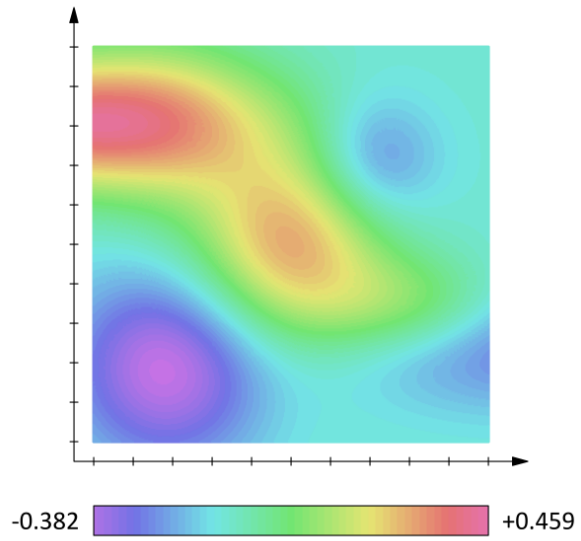
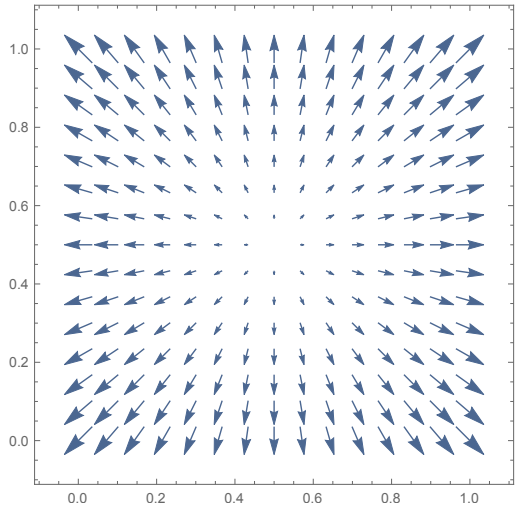


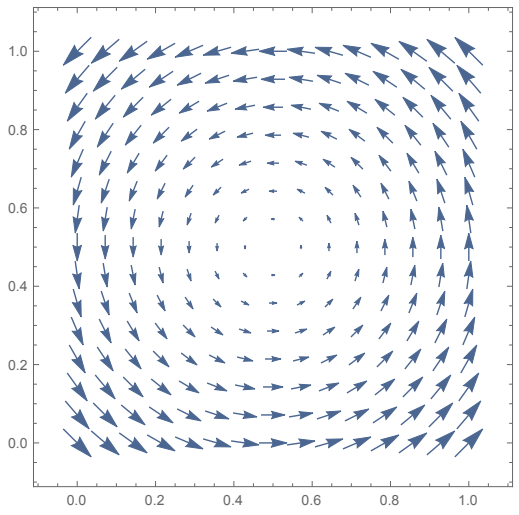
Figure: Scalar field, *Source:* ①

Introduction - Vector Fields

- Vector fields are visualized by a collection of arrows with a given magnitude and direction classically
- Each position in space is mapped a scalar magnitude and an angle
- Examples: flow field, magnetic field, gravitational field



a)



b)

Figure: Vector fields: a) $\{x, y\}$, b) $\{-y, x\}$

Introduction - Tensor Fields

- Tensor fields are commonly visualized by:
  - Glyphs
  - Tensor field lines (TFLs)
    $\Rightarrow$ Hyperstreamlines
- Each position in space is mapped a tensor describing a directional distribution
- Scalar Measures: anisotropy index, tensor magnitude

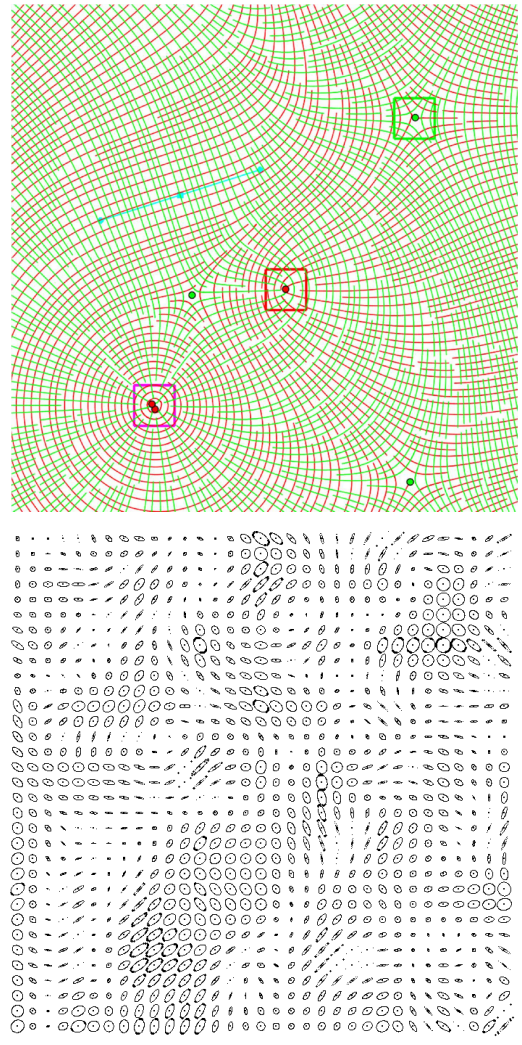
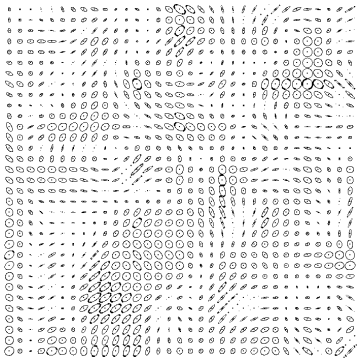
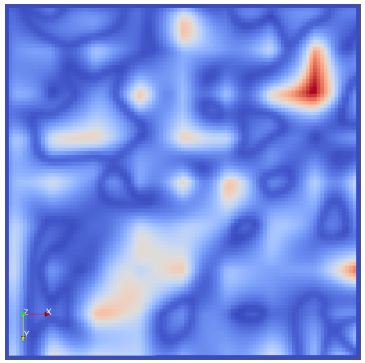


Figure: Tensor fields: a) Tensor field lines, b) Glyphs

Motivation - Tensor Fields


a)

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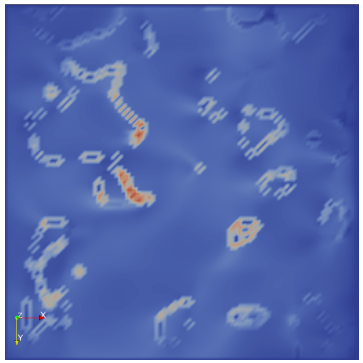

c)

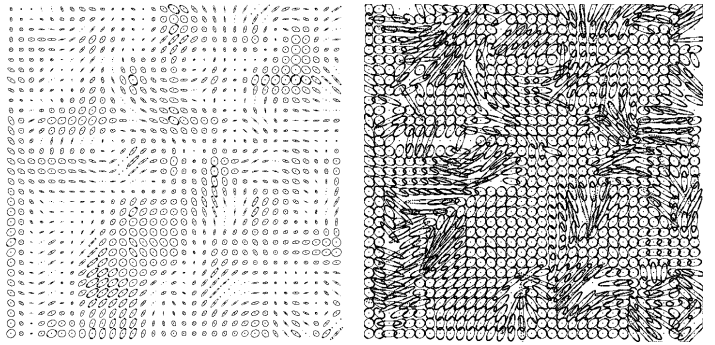
Figure: Random field: a) field, b) tensor magnitude, c) FTLE

Applications:

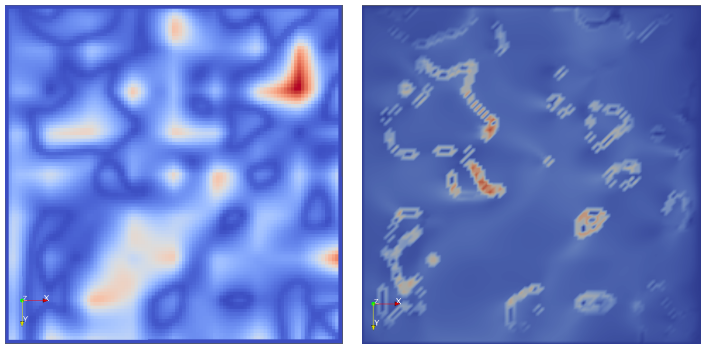
- Vector fields: to describe the directionally dependent spatial gradient called Jacobian-matrix,
- Fluid and solid continuum mechanics: to describe a whole distribution of stresses
- DT-MRI: diffusion tensor - magnetic resonance imaging: to describe the diffusion characteristics of water molecules within tissue

Random Test Field

- Tensor fields are commonly visualized by:
  - Glyphs
  - Tensor field lines (TFLs)
    $\Rightarrow$ Hyperstreamlines
- Each position in space is mapped a tensor describing a directional distribution
- Scalar Measures: anisotropy index, tensor magnitude



a) b)



c) d)

Figure: Random test field : a) Global, b) Local normalization, c) Tensor mag. d) LTG (FTLE)